

test) or in a confined space (close test). For lubricating oils the close test may be made either by Gray's or the Pensky-Martin instrument, in which the oil is heated in a closed cup which is momentarily opened to allow contact with a flame. A thermometer dips into the oil, and uniformity of temperature is maintained by constant stirring with a paddle. A flash-point not under 350° F. is desirable in lubricating oils for use inside buildings.

The *setting-point* is the temperature at which an oil becomes stiff and ceases to flow. The sample in a corked test-tube is cooled either in water or in a freezing mixture until it remains in position on reversing the tube. The temperature should be held constant for about twenty minutes before observing the oil.

Chemical Tests.—For more complete characterization of a lubricating oil a chemical examination is necessary to supplement the physical tests. This generally includes some or all of the following:

1. Examination for mineral acid.
2. Determination of suspended matter.
3. Gumming and volatility tests.
4. Determination of total acidity.
5. Determination of unsaponifiable matter.
6. Iodine value.

To test for mineral acid, which if present would actively corrode metal bearings, a weighed quantity is vigorously agitated with water, allowed to stand, and a drop of methyl orange solution added. A pink colour indicates mineral acid which may be estimated by titration with alkali.

Suspended matter is separated by thinning a weighed sample with ether and passing through a weighed filter which is afterwards carefully washed with ether till free of oil and dried at 212° to 220° F.

Volatility is a property which in the case of mineral-oil lubricants must be carefully watched as, in contrast to fatty oils, these may contain a proportion vaporizing at moderate temperatures. Archbutt's test consists in subjecting 0.5 gm. of the oil placed in a shallow boat within a heated tube to a current of air passed at the rate of 2 litres per minute for one hour. The air is previously heated to the desired temperature.

Gumming may be tested for by warming 1 gm. on a watch-glass for twelve hours in a boiling-water oven. Liability to

decomposition is a property that under certain conditions must be taken into consideration.

For cylinder lubrication in high-pressure steam and in gas-and-oil-engines pure fatty oils are unsuitable. For the former a blended oil or a mineral oil of suitable viscosity may be used; for the latter pure mineral oils only are to be preferred of a type not readily carbonized on heating.

The more elaborate chemical tests for lubricants are those in use for examination of oils in general. For details of working reference may be made to the special textbooks dealing with the analysis of oils and fats.